What is claimed is:

1.   A method for recursively determining alignment of a flight vehicle during flight, the method comprising:

generating two flight dynamics or trajectory data in a reference coordinate frame and in a second coordinate frame at a plurality of points in time during the flight; and

at each point in time,

constructing a first matrix based on the two flight dynamics or trajectory data in the reference coordinate frame at that time;

constructing a second matrix based on the two flight dynamics or trajectory data in the second coordinate frame at that time;

modifying a first accumulation matrix based on the first matrix and the second matrix;

modifying a second accumulation matrix based on the second matrix;

inverting the first accumulation matrix; and

determining an alignment output based on the inverted first accumulation matrix and the second accumulation matrix.

2.   The method of claim 1, wherein the first matrix is based on a matrix with the form:

$$u_i^I = \left[\underline{a}_i^I \ , \ \underline{b}_i^I \ , \ \underline{a}_i^I \times \underline{b}_i^I \right]$$

wherein the vector $\underline{a}$ is the pseudo position vector and the vector $\underline{b}$ is the pseudo velocity vector.

3.   The method of claim 1, wherein:

modifying the first accumulation matrix further comprises using a weighting function; and

modifying the second accumulation matrix further comprises using a weighting function.

4.   The method of claim 3, wherein the weighting function comprises the sine of the angular separation between the two flight dynamics or trajectory vectors.

5.   The method of claim 1, wherein:

generating flight dynamics or trajectory data in a reference coordinate frame comprises generating flight dynamics or trajectory data using a reference inertial measurement unit (IMU); and

generating the flight dynamics or trajectory data in the second coordinate frame comprises generating flight dynamics or trajectory data using a second IMU.

6.   The method of claim 1, wherein determining an alignment output comprises determining a direction cosine matrix that defines the orientation of the second coordinate frame with respect to the reference coordinate frame.

7.   A method for recursively determining alignment of a reentry body of a flight vehicle during flight, the method comprising:

generating flight dynamics or trajectory data in a reference coordinate frame based on data from a reference inertial measurement unit (IMU) of the flight vehicle;

generating flight dynamics or trajectory data in a second coordinate frame based on data from a second IMU located on the reentry body;

wherein the flight dynamics or trajectory data in the reference coordinate frame and in the second coordinate frame is generated at a plurality of points in time during the flight; and

at each point in time,

constructing a first matrix based on the flight dynamics or trajectory data in the reference coordinate frame at that time;

constructing a second matrix based on the flight dynamics or trajectory data in the second coordinate frame at that time;

modifying a first accumulation matrix based on the first matrix and the second matrix using a weight based on the sine of the angular separation between the pseudo position and velocity;

modifying a second accumulation matrix based on the second matrix using a weight based on the sine of the angular separation between the pseudo position and velocity;

inverting the first accumulation matrix; and

determining a direction cosine matrix defining the orientation of the reference coordinate frame with respect to the second coordinate frame based on the inverted first accumulation matrix and the second accumulation matrix.

8.   A method for recursively determining alignment of a flight vehicle during flight, the method comprising:

generating data in a reference coordinate frame and in a second coordinate frame at a plurality of points in time during the flight;

recursively generating first and second matrices from the data in the reference coordinate frame and the second coordinate frame; and

at each point in time, determining an alignment output based on the inverted first matrix and the second matrix.

9.   The method of claim 8, wherein recursively generating first and second matrices comprises, for each of the plurality of points in time:

constructing a first base matrix based on the data in the reference coordinate frame at the point in time;

constructing a second base matrix based on the data in the second coordinate frame at the point in time;

modifying a first accumulation matrix based on the first and second base matrices;

modifying a second accumulation matrix based on the second base matrix;

providing the first and second accumulation matrices as the first and second matrices.

10.   The method of claim 8, wherein determining an alignment output comprises determining a direction cosine matrix that defines the orientation of the second coordinate frame with respect to the first reference coordinate frame.

11.   The method of claim 8, wherein generating data in a reference coordinate frame comprises generating pseudo position and velocity data.

12. The method of claim 8, wherein generating data in a reference coordinate frame comprises generating acceleration and angular rate data.

13. The method of claim 8, wherein generating data in a reference coordinate frame comprises generating data from the output of an inertial measurement unit (IMU).

14. A system for controlling alignment during a flight, comprising:

a first flight vehicle having a reference inertial measurement unit with a reference coordinate frame;

a second flight vehicle having a second inertial measurement unit with a second coordinate frame;

an alignment processor, coupled to the reference IMU and the second IMU, the alignment processor adapted to receive data in the reference coordinate frame and in the second coordinate frame at a plurality of points in time from the reference IMU and the second IMU during the flight, recursively generate first and second matrices from the data in the reference coordinate frame and the second coordinate frame, and at each point in time, determine an alignment output based on the inverted first matrix and the second matrix; and

a navigation computer, coupled to the processor, that is adapted to receive the alignment output to control the trajectory of the second flight vehicle.

15. The system of claim 14, wherein the second flight vehicle comprises a reentry body.

16. The system of claim 14, wherein the reference IMU and the second IMU produce pseudo position and velocity data.

17. The system of claim 14, wherein the alignment processor produces a direction cosine matrix defining the orientation of the second coordinate frame with respect to the reference coordinate frame.

18. The system of claim 14, wherein alignment processor uses a weighting function in recursively generating the first and second matrices.

19. The system of claim 14, wherein the alignment processor uses a weighting function based on a sine of the angular separation between pseudo position and velocity vectors in recursively generating the first and second matrices.

20. A machine readable medium having instructions for performing a method for recursively determining alignment of a flight vehicle during flight, the method comprising:

generating two flight dynamics or trajectory data in a reference coordinate frame and in a second coordinate frame at a plurality of points in time during the flight; and

at each point in time,

constructing a first matrix based on the two flight dynamics or trajectory data in the reference coordinate frame at that time;

constructing a second matrix based on the two flight dynamics or trajectory data in the second coordinate frame at that time;

modifying a first accumulation matrix based on the first matrix and the second matrix;

modifying a second accumulation matrix based on the second matrix;

inverting the first accumulation matrix; and

determining an alignment output based on the inverted first accumulation matrix and the second accumulation matrix.

21. The machine readable medium of claim 20, wherein the first matrix is based on a matrix with the form:

$$u_i^I = \left[\underline{a}_i^I \ , \ \underline{b}_i^I \ , \ \underline{a}_i^I \times \underline{b}_i^I \right]$$

wherein the vector $\underline{a}$ is the pseudo position vector and the vector $\underline{b}$ is the pseudo velocity vector.

22. The machine readable medium of claim 20, wherein:

modifying the first accumulation matrix further comprises using a weighting function; and

modifying the second accumulation matrix further comprises using a weighting function.

23.   The machine readable medium of claim 22, wherein the weighting function comprises the sine of the angular separation between the two flight dynamics or trajectory vectors.

24.   The machine readable medium of claim 20, wherein:
generating flight dynamics or trajectory data in a reference coordinate frame comprises generating flight dynamics or trajectory data using a reference inertial measurement unit (IMU); and
generating the flight dynamics or trajectory data in the second coordinate frame comprises generating flight dynamics or trajectory data using a second IMU.

25.   The machine readable medium of claim 20, wherein determining an alignment output comprises determining a direction cosine matrix that defines the orientation of the second coordinate frame with respect to the reference coordinate frame.

26.   A machine readable medium having instructions for performing a method for recursively determining alignment of a reentry body of a flight vehicle during flight, the method comprising:
generating flight dynamics or trajectory data in a reference coordinate frame based on data from a reference inertial measurement unit (IMU) of the flight vehicle;
generating flight dynamics or trajectory data in a second coordinate frame based on data from a second IMU located on the reentry body;
wherein the flight dynamics or trajectory data in the reference coordinate frame and in the second coordinate frame is generated at a plurality of points in time during the flight; and
at each point in time,
constructing a first matrix based on the flight dynamics or trajectory data in the reference coordinate frame at that time;
constructing a second matrix based on the flight dynamics or trajectory data in the second coordinate frame at that time;
modifying a first accumulation matrix based on the first matrix and the second matrix using a weight based on the sine of the angular separation between the pseudo position and velocity;

modifying a second accumulation matrix based on the second matrix using a

weight based on the sine of the angular separation between the pseudo

position and velocity;

inverting the first accumulation matrix; and

determining a direction cosine matrix defining the orientation of the reference

coordinate frame with respect to the second coordinate frame based on the

inverted first accumulation matrix and the second accumulation matrix.

27.   A machine readable medium having instructions for performing a method for recursively determining alignment of a flight vehicle during flight, the method comprising:

generating data in a reference coordinate frame and in a second coordinate frame at a plurality of points in time during the flight;

recursively generating first and second matrices from the data in the reference coordinate frame and the second coordinate frame; and

at each point in time, determining an alignment output based on the inverted first matrix and the second matrix.

28.   The machine readable medium of claim 27, wherein recursively generating first and second matrices comprises, for each of the plurality of points in time:

constructing a first base matrix based on the data in the reference coordinate frame at the point in time;

constructing a second base matrix based on the data in the second coordinate frame at the point in time;

modifying a first accumulation matrix based on the first and second base matrices;

modifying a second accumulation matrix based on the second base matrix;

providing the first and second accumulation matrices as the first and second matrices.

29.   The machine readable medium of claim 27, wherein determining an alignment output comprises determining a direction cosine matrix that defines the orientation of the second coordinate frame with respect to the first reference coordinate frame.

30. The machine readable medium of claim 27, wherein generating data in a reference coordinate frame comprises generating pseudo position and velocity data.

31. The machine readable medium of claim 27, wherein generating data in a reference coordinate frame comprises generating acceleration and angular rate data.

32. The machine readable medium of claim 27, wherein generating data in a reference coordinate frame comprises generating data from the output of an inertial measurement unit (IMU).